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EFFICIENCY OF IMPEDANCE SPECTROSCOPY IN SENSOR TECHNIQUES

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ABSTRACT: Impedance spectroscopy has great efficiency in materials engineering. This is due to its ability to measure high spectrum of frequencies (range of 50 Hz to 1 MHz) and corresponding values of resistance, impedance, phase angle, quality factors, as well as to give better information about material's behaviour.

KEY WORDS: RCL meter, electrode, electric properties

1. INTRODUCTION

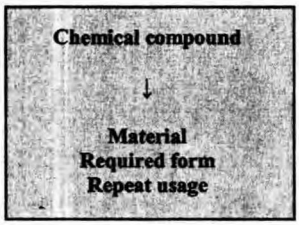
Nowadays, the thin layered materials and structures present the essential components of technical progress and industrial application. The interest about thin films and structures reaches back to the 20th century, as does the increase in the strong research of new materials and technologies [1-3], mainly in optics and optical applications.

Requirements of the miniaturization of semiconductors electronics and the new technologies in electronics are bounded to physics of thin films.

Physics orientation on low dimensional structure researches their properties and application in connection with a strong support in nanoresearch, what leads to better knowledges and solutions.

However, the achievements of the basic and application research arouse illusions, hypothesis, unexpected investigations...

Materials today –



Ceramics, fabric glass, metals, alloys, intermetallic, polymeric materials – organic, inorganic, Semiconductors Si, Ge...
Composites, hybrid materials

Nanomaterials! = NEW MATERIALS!

Study of material chemistry consists of a preparation of compounds with required:
- Morphology, form, particle size, porous
- Crystallinity – amorphous, crystalline

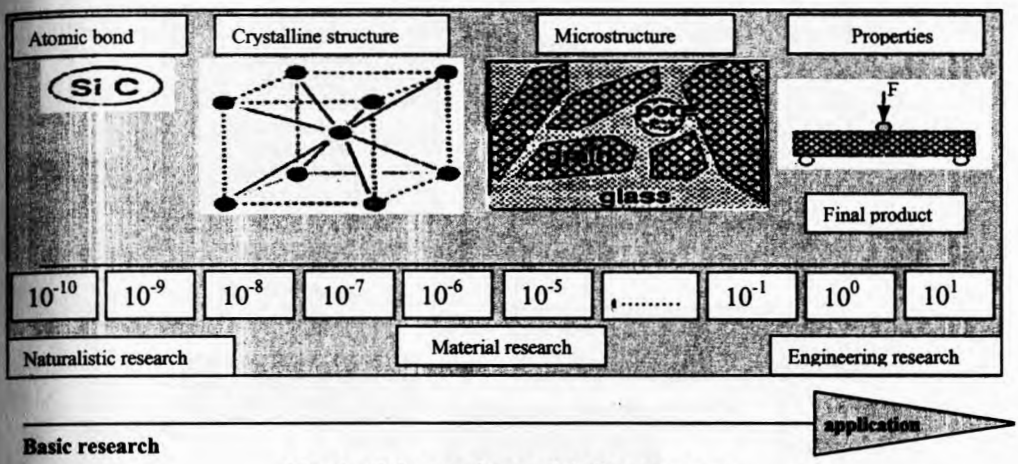


Fig. 1: Scheme of materials flow-process

Material research brought out the differences between chemical and phase composition, such as morphology of the physical and chemical properties.

Particle size is the next "variable" which influences material's properties.

In area of the transition between molecular and macroscopic grains is the area of nano scale, where the properties don't occur at molecular and volume parameters.

If we judge a problem with nanoparticles and nanomaterials (particle size 1-100 nm), it arouses a question about number of external and internal atoms – their ratio, particle size, these parameters influence chemical and physical properties.

The acute change of mechanical, optical or electrical properties occurred along with reduction of particles Nanomaterials, in comparison to macroscopical forms, have different chemical reactivity, thaw point, colour change and electrical properties.

Preparation of nanoparticles is possible in two cases. First one, so called Bottom-up case, is the synthesis of nano blocks – there are small or bigger molecules, clusters, and polyedrical molecule, e.g. pyrolysis, sol-gel methods, ultrasound.

The second case, so called Top-down, is the structural dissociation of compact solid in process of nanoparticles creation, e.g. mixing, extrusion, detonation.

Sol-gel method is a typical method of specially prepared non-metallic materials – they are widely used in materials engineering mainly for preparation of films which modify physical and chemical properties of various substrata. This method is being preferred because of its simple way of preparation of wide scale of thin films with different chemical composition by the use of less expensive vacuum technologies. Described method allows us to prepare types of material, which couldn't be prepared with the use of another methods, e.g. inorganic-organic materials, nanocomposites [2].

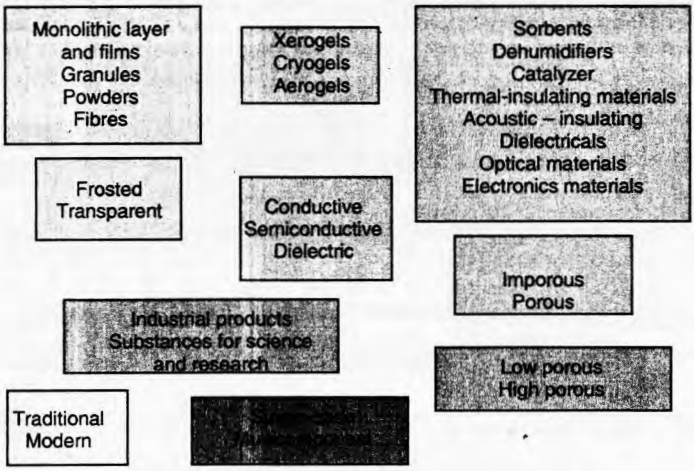


Fig. 2: The main areas of the sol-gel method

The most important advantages of sol-gel method are:

- Possibility of continuous change of physical parameters of products,
- Possibility of low temperature preparation,
- High cleanness of products,
- High homogeneity of products,
- Absence of crystalline phases,
- Possibility of choice of products form by method of casting.

Disadvantages characterizing the sol-gel method are:

- High price of the input chemicals,
- Time demandingness of preparation,
- Toxicity of the outputs,
- Volatility of solvents,
- Very limited possibilities of the additional form product modification,
- Quite critical preparation conditions – in many cases.

The efficiency of impedance spectroscopy is wide. Close to the base of material engineering which is nowadays the priority field of Faculty of Industrial Technologies – thin films, nanotubes; is used in another field – e.g. astronautics, army etc.

Consequence of chemistry is using the measurement of electric parameters on thin films which are deposit on the electrode – creation of sensor. These thin films are made by sol-gel method.

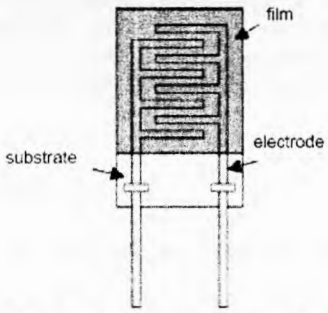


Fig. 3: Sensor structure [3]

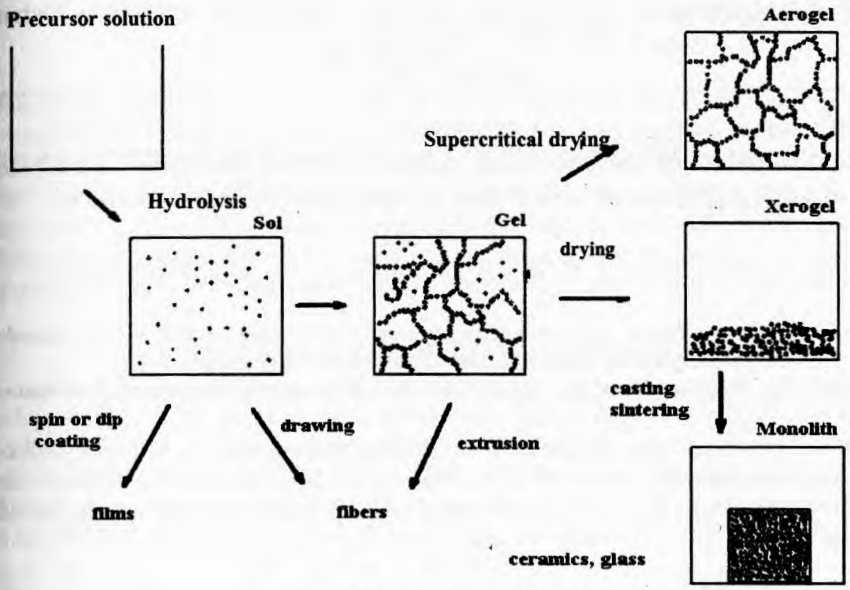


Fig. 4: Sol-gel method [4]

The research on influence of electric parameters in consequence of the various humidity of solution has already started – we realized some pilot measurements, but this paper is informative input description about influences on material behaviour and explanation.

2. REFERENCES

[1] EXNAR, P.: Metoda sol-gel, Technická univerzita v Liberci 2006, ISBN 80- 7372-063-9.
[2] OŠŤÁDA: Metody studia tenkých vrstev, ZPRAVODAJ ČVS 15, (1-2) 2007.
[3] ŠTENGL, V., ŠUBRT, J.: Nanomateriály, Chem. Listy 98, 2004, 324-327.
[4] PINKAS, J.: Materiálová chemie - Syntéza lepších a ješte lepších materiálu, 2006.